NQA-1

AN OVERVIEW FOR FEDERAL PROJECT DIRECTORS

WHAT IS NQA-1?

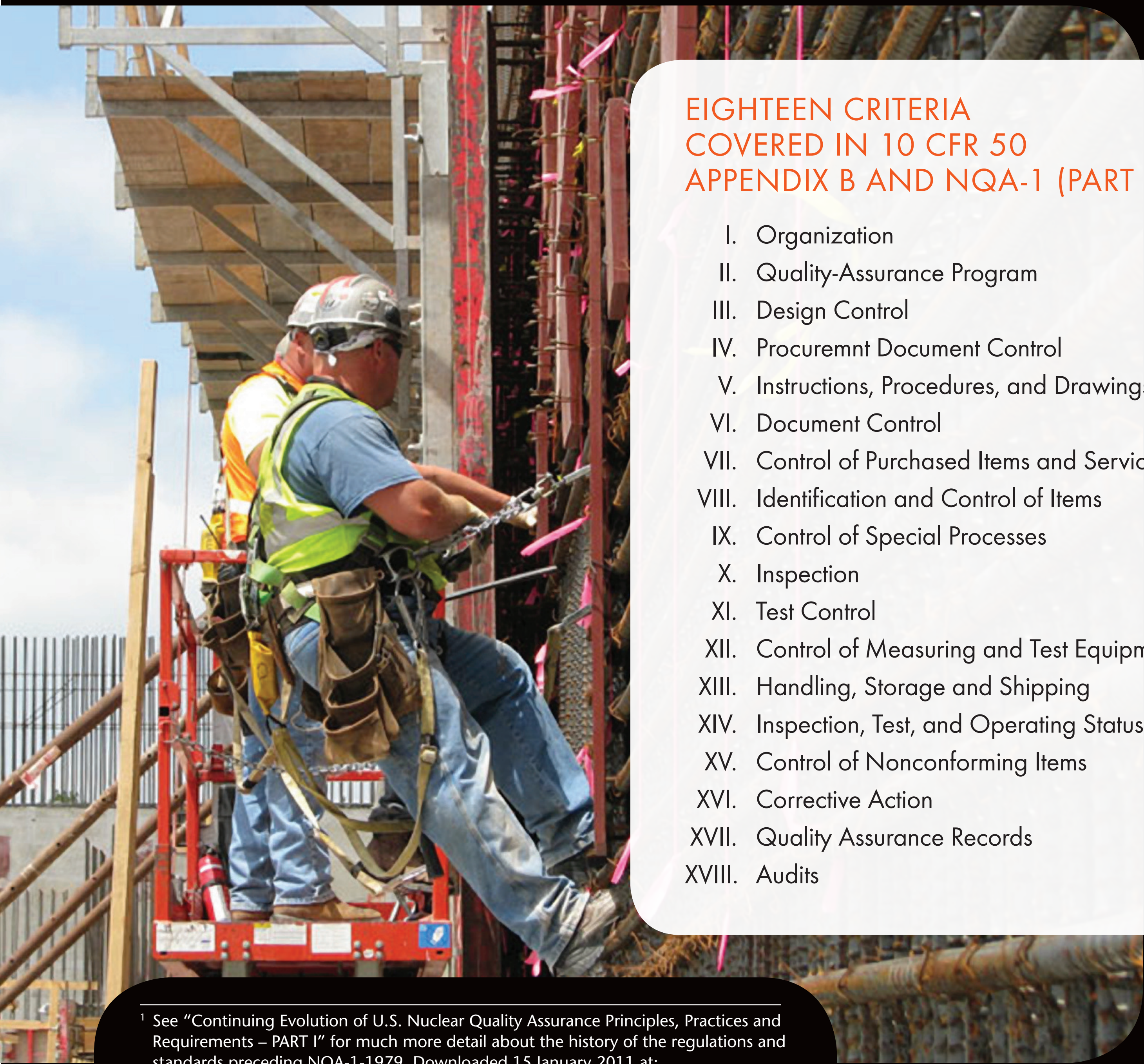
NQA-1 is a national consensus standard for quality assurance for nuclear material applications, structures, systems, and components of nuclear facilities. Published by the American Society of Mechanical Engineers (ASME), NQA-1 evolved as guidance for implementing the federal regulations pertaining to quality assurance for nuclear power plants and fuel reprocessing plants. The relevant section in the Code of Federal Regulations, 10 CFR Part 50 Appendix B ("Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"), best explains the applicability of both the regulations and NQA-1:

> "…all activities affecting the safety related functions of those structures, systems, and components; these activities include designing, purchasing, fabricating, handling, shipping, storing, cleaning, erecting, installing, inspecting, testing, operating, maintaining, repairing, refueling, and modifying."

It is important to note that the phrase "*all activities affecting the safety related functions*" limits the scope of NQA-1's applicability. Many of the buildings and systems at a nuclear facility do not perform safety-related functions, and thus can fall under less stringent regulations and standards such as ISO-9000.

HISTORY

NQA-1 was not the first nuclear quality assurance standard to address 10 CFR 50 Appendix B, which was codified into law in 1970 by the Atomic Energy Commission (AEC).[1] Prior to the development of NQA-1, the American National Standards Institute (ANSI) issued ANSI N45.2-1971, "Quality Assurance Program Requirements for Nuclear Power Plants." Throughout the 1970s, as the number of nuclear power plants in the United States expanded dramatically, ANSI issued multiple revisions of N45.2, and the AEC published guidance on the implementation of 10 CFR 50 in its "Gray Book" and regulatory guides. By 1975, ANSI's N45 Committee assigned responsibility for nuclear quality assurance standards to an ASME Committee on Nuclear Quality Assurance (NQA), laying the groundwork for NQA-1.



EIGHTEEN CRITERIA COVERED IN 10 CFR 50 APPENDIX B AND NQA-1 (PART I)

I. Organization
II. Quality-Assurance Program
III. Design Control
IV. Procuremnt Document Control
V. Instructions, Procedures, and Drawings
VI. Document Control
VII. Control of Purchased Items and Services
VIII. Identification and Control of Items
IX. Control of Special Processes
X. Inspection
XI. Test Control
XII. Control of Measuring and Test Equipment
XIII. Handling, Storage and Shipping
XIV. Inspection, Test, and Operating Status
XV. Control of Nonconforming Items
XVI. Corrective Action
XVII. Quality Assurance Records
XVIII. Audits

[1] See "Continuing Evolution of U.S. Nuclear Quality Assurance Principles, Practices and Requirements – PART I" for much more detail about the history of the regulations and standards preceding NQA-1-1979. Downloaded 15 January 2011 at: http://www.hss.doe.gov/nuclearsafety/qa/docs/NQAStandardsEvolution1.doc

VERSIONS

ASME released the first version of the standard as NQA-1-1979. Mirroring the structure of 10 CFR 50, NQA-1-1979 consisted of 18 requirements "intended to meet and implement the criteria of 10 CFR 50 Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, dated January 20, 1975."[2] ASME has since issued revisions of NQA-1 in 1983, 1986, 1989, 1994, 1997, 2000, 2004, and 2008.

In 1983, ASME also issued NQA-2, "Quality Assurance Requirements for Nuclear Facility Applications," and in 1989 it published NQA-3, "Quality Assurance Program Requirements for the Collection of Scientific and Technical Information on Site Characterization of High-Level Nuclear Waste." With NQA-1-1994, ASME subsequently incorporated NQA-2 and NQA-3 into a three-part version of NQA-1, with Part I retaining the 18-criteria structure of 10 CFR 50 Appendix B. The latest version, NQA-1-2008 follows a four-part structure:

- PART I: Requirements for Quality Assurance Programs for Nuclear Facilities
- PART II: Quality Assurance Requirements for Nuclear Facility Applications
- PART III: Non-mandatory Appendices
- PART IV: Non-mandatory Appendices: Positions and Applications Matrices

Across the nuclear enterprise, different facilities follow different versions of NQA-1. As early as 1985, the Nuclear Regulatory Commission (NRC) endorsed parts of NQA-1-1983 in its regulatory guides, but it has not endorsed every version or all parts of the standard.[3] In addition to endorsements in regulatory guides, NRC approval can be inferred from its acceptance of commercial licensing applications that have proposed to use NQA-1 as an implementation guide for 10 CFR 50 Appendix B. The first version to be accepted in a licensing application was NQA-1-1994. The NRC has subsequently accepted part of NQA-1-2000 in Exelon's application for a reactor in Clinton, Illinois.[4]

The fact that commercial facilities (e.g., power plants) and DOE nuclear facilities are subject to different regulations and authorities further complicates the question of versions. The NRC regulates commercial plants, while DOE regulates its own facilities. [The Mixed Oxide (MOX) Fuel Fabrication Facility, which is regulated by the NRC, is an exception.] Unlike commercial plants subject to 10 CFR 50, DOE facilities follow 10 CFR 830 ("Nuclear Safety Management") Subpart A—"Quality Assurance Requirements." DOE facilities are also subject to DOE Order 414.1C, "Quality Assurance," which references NQA-1-2000.

Since there is no clear industry-wide consensus on a definitive version, facility operators, vendors, and suppliers follow different versions. Many industry experts still consider NQA-1-1994 the "gold standard." Since decisions regarding the different versions of NQA-1 ultimately rest with facility operators and regulators, vendors will follow whichever version their customers specify during the acquisition process.

[2] ASME NQA-1-2008, Foreword, p. iv.

IMPLEMENTING A NQA-1 PROGRAM

Establishing an NQA-1 program for the construction of a nuclear facility requires a significant level of organizational infrastructure. While the structure of a quality assurance (QA) organization differs slightly in commercial and DOE facilities, there are shared fundamental principles. First and foremost, the QA team must be able to function independently from the organizations it is responsible for overseeing. This includes having the authority to stop work or bring an issue independently "up the chain" to the site manager or other top executive as defined by the facility's governance model.

The centerpiece of a facility's NQA-1 implementation is a quality assurance program, which should be based on a set of verifiable procedures that are directly traceable to 10 CFR 50. (The number of procedures may vary from facility to facility.) The quality assurance program includes planning for quality assurance activities as well as the "indoctrination, training, and qualification" of the personnel who will execute the activities. NQA-1 does not specify how to structure a QA organization, but the primary roles typically include:

- **Internal QA—**responsible for audits and surveillance of internal work and processes
- **External QA—**responsible for audits and surveillance of suppliers and vendors
- **Quality Control (QC)—**responsible for welding inspections, non-destructive evaluation (e.g., radiographic, magnetic particle inspections), and other testing

The activities performed in the QA program yield measurable outputs. "Implementation generates hard data," said Jim Broughton of Applied Engineering Services. "It's quantitative, not qualitative." The effectiveness of the QA organization's response to a finding depends on its corrective action plan. The discovery of an inferior quality part, for example, should lead to further findings about the product itself as well as how the organization operates.

Within the DOE facilities surveyed for this paper, the federal project directors (FPD) report that the most significant internal difficulty is adequate staffing, such as the appropriate number of qualified inspectors. This can be particularly challenging for highly skilled trades such as welding.

OVERHEAD AND COST

The overhead associated with establishing and maintaining an NQA-1-compliant nuclear QA program carries significant cost implications, ranging from internal staffing and training to higher costs from vendors with NQA-1 programs. "There's a lot of infrastructure that goes with the implementation," said Jim Broughton.

For example, the cost of a piece of equipment can be five to ten times higher than for an identical piece manufactured to a less rigorous standard. "Even though the equipment would be the same, the cost of the qualification documentation that goes along with the certificate

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[3] See "Continuing Evolution of U.S. Nuclear Quality Assurance Principles, Practices and Requirements – PART I," pp. 8 and 43, regarding the NRC's endorsement of NQA-1-1983 in Regulatory Guide 1.28.

[4] See Exelon's early site permit application to the NRC, Chapter 17, Early Site Permit Quality Assurance Measures, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1844/, as noted in "Continuing Evolution of U.S. Nuclear Quality Assurance Principles, Practices and Requirements – PART I," p. 42.

(sometimes called a green tagged item) can cost ten times what it does for a non-safety-related piece of equipment," said Ted Quinn of Longenecker & Associates, a past president of the American Nuclear Society.

An overly broad approach to NQA-1 implementation at a facility can lead to the over-engineering of systems that do not perform a nuclear safety-related function, resulting in higher costs than necessary. "Once you establish NQA-1 at the top of the pyramid, it gets applied to everything," said Dave Swindle, URS Corporation, who serves as a member of DOE's Environmental Management Advisory Board (EMAB). For DOE facilities, Swindle emphasized the need to plan for QA during the acquisition process. "Whatever your standard NQA-1 requirements are, there has not been consistently a determination during planning of the acquisition strategy of what is the appropriate level of QA commensurate with either the risk or the material at hand. If it's not done there, then it permeates throughout the organization and throughout the acquisition as well."

ALIGNMENT

At DOE laboratories, issues can emerge regarding the alignment of QA organizations. Since most labs typically host a range of facilities and research projects, there are often multiple QA organizations following different standards across the laboratory. While NQA-1 imposes a high level of rigor on nuclear safety-related functions, other organizations within a lab may develop QA organizations that carry less stringent requirements. The absence of clear laboratory-wide direction can lead to a cafeteria approach in which organizations pick their own QA standards. "Alignment of quality assurance groups among the organizations at a laboratory is a major task," said Ed Webb, an independent consultant who has served as an NQA-1 lead auditor.

VENDOR BASE

NQA-1 implementation during construction requires using NQA-1 qualified vendors and suppliers. The current vendor base in the United States poses challenges for many DOE and commercial facilities.

The existing gaps in the vendor base in the United States are a result of the contraction of the nuclear industry that took place after the Three Mile Island accident in 1979. As new plant construction halted, many U.S. vendors either consolidated or went out of business. At the same time, the nuclear industry expanded globally, leading to the establishment of industrial base capabilities in nations such as France, Japan, and South Korea. The disappearance of some of these capabilities in the United States has left no alternative to reliance on foreign suppliers. For example, there is only a limited number of suppliers worldwide capable of manufacturing heavy forgings for reactor vessels. In recent years this has led to lengthy backlogs as more facilities around the world have initiated construction.

Since foreign suppliers are not required to follow NQA-1, which is an American industry standard, organizations purchasing foreign equipment can conduct a gap analysis of the standard used against NQA-1 to demonstrate equivalence. A commercial-grade dedication process can also be employed to assure the quality of foreign equipment. (See more about commercial-grade dedication below.) For DOE facilities, the use of foreign suppliers is also bounded by national security concerns and regulations.

The current gaps in the U.S. vendor base manifest themselves in one of two ways: 1) in some parts of the supply chain or construction industry, there are not enough vendors with NQA-1 programs, and 2) those that had active NQA-1 programs in decades past often do not have recent experience in the nuclear industry and do not understand the associated rigor. "If you haven't exercised the program, either you've lost or don't have the corporate memory," said Jack Kasper, Vice President of Nuclear Engineering for Parsons Commercial Technology Group.

ASME's nuclear component certification program for mechanical equipment results in the issuance of an "N Stamp" to qualified NQA-1 suppliers. Due to the high overhead associated with implementing and maintaining an NQA-1 program as well as the necessary indemnification associated with equipment certified for use in nuclear safety systems, some commercial suppliers choose not to become certified vendors. "N Stamp manufacturers have not started coming back yet. The market just isn't there," said Jeff Larson, Nuclear Quality Director for Invensys.

If a qualified supplier for a given system or piece of equipment cannot be found, a commercial-grade dedication process can provide assurance that a piece of equipment manufactured to commercial standards also meets the NQA-1 standard. This essentially shifts the burden of assuring NQA-1 compliance from the supplier to the buyer.

"It takes utilities as well as DOE projects a significant amount of time either to work with the vendors and help them develop a quality assurance program to the level that you need, or have to go in and do a commercial-grade dedication on the parts that you get from them," said Ed Webb. "Either method is acceptable, and it takes a long time and a lot of effort and resources."

A relatively new challenge for the industry is QA for software and digital control systems. "When NQA-1 was written, there wasn't any software to speak of," said Jeff Larson. With chips, sensors, and digital controls incorporated into systems that previously only featured mechanical equipment, facilities must now conduct a significant amount of software quality assurance testing. Through its regulatory guides, the NRC has endorsed the Institute of Electrical and Electronic Engineers' (IEEE) standard (IEEE-1012) for software verification and validation (V&V). "V&V should be viewed the same as the traditional QA organization—as an inspecting, testing, and reviewing function that requires independence in order to meet the regulation," said Larson.

The NRC can also provide a Safety Evaluation Report (SER) of a system or platform built by a digital supplier that lets a customer know that the NRC has pre-approved the digital system for licensing. In practice, this functions similarly to an N Stamp for digital controls. The NRC has issued very few of these to date.

URANIUM PROCESSING FACILITY (UPF)

PROJECT PROFILE	The Uranium Processing Facility Project, part of the Y-12 National Security Complex, is a ~350,000 square-foot facility being designed to house DOE's enriched uranium processing capability.
STATUS	As of January 2011, the project team has completed just over 45 percent of its design, and it has not begun construction yet or awarded contracts for procurements.

The project team has incorporated NQA-1 requirements since its inception, and the primary challenge to date has involved finding qualified vendors and training design teams. "The vendor base is not out there for the nuclear side of the house," said FPD Harry Peters.

Peters's team has initiated activities for long-lead procurements, including Requests for Information (RFI) and Requests for Proposals (RFP), and it has already seen confusion in the responses received from vendors. Some of this confusion is apparent in the variation in the costs proposed by vendors, as well as the questions received. Peters noted that the current level of confusion has not even involved difficult procurements. "They're long lead-time procurements, but they're not particularly challenging," he said. At this phase of the project, he cannot estimate the cost or schedule impact of NQA-1.

On a broad level, Peters sees evidence that vendors underestimate the level of effort required to achieve NQA-1 compliance. "There's a rigor that's applied to any vendor—the verification that they have a program and that they're implementing the program," he said. "Is the vendor willing to live and operate within that scrutiny? Many do not understand the intensity, especially with safety-class and safety significant (systems and equipment)."

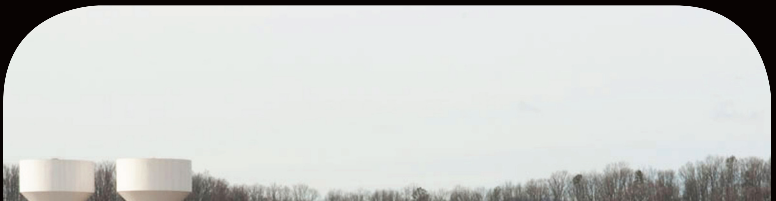
From Peters's perspective, the success of an NQA-1 program requires more than a checklist mentality. "Whether you're in design, equipment fabrication, or material fabrication, you have to have your whole manufacturing process built with a NQA-1 mindset," he said. "You can't just put it on a piece of paper and say, 'Go do it.' You have to have this respect for that quality assurance level."

A problem resulting from the gaps in the vendor base is the need to certify equipment made in non-NQA-1-compliant shops. "There's such a lack of vendors with NQA-1 programs, so commercial-grade dedication rises to the top

as the way we solve that problem," he said. "That's not a good way to do business, but if those are the only vendors out there, that's what we have to do."

Peters has benefited from collaboration and informal sharing of best practices with other DOE project teams, particularly MOX, CMRR, and HEUMF. UPF is currently developing its commercial-grade dedication program in collaboration with CMRR.

Along with concerns about the vendor base, Peters faces the challenge of overseeing and managing the procurements for his project. "We don't have all the qualified resources we need on the project to go out and validate these vendors. We need to go out and find that capability."



HIGHLY ENRICHED URANIUM MATERIALS FACILITY (HEUMF)

PROJECT PROFILE The Highly Enriched Uranium Materials Facility (HEUMF), also part of the Y-12 National Security Complex, is a massive concrete and steel structure that serves as the nation's central repository for receiving, shipping, and providing long-term storage of highly enriched uranium.

STATUS The project team received its CD-4 approval signifying project completion in March 2010.

Dale Christenson, who became the HEUMF FPD when the construction was already underway, said that the project experienced a learning curve regarding NQA-1. "We didn't really have an appreciation of the effort required to implement nuclear QA requirements," he said. "Within the department as a whole and especially here at Y-12, we hadn't built a new nuclear facility in a long time. The only nuclear construction we'd done were modifications of existing nuclear facilities." Other QA programs onsite at Y-12 were geared for these smaller modifications.

"There was not a clear understanding of what (DOE Order) 414.C required for nuclear construction," said Christenson. HEUMF contract specifications required the implementation of DOE O 414.C, which encourages the use of national consensus standards such as NQA-1 and ISO-9001. At the time, there was not a strong push to use NQA-1.

The project's general contractor chose to use NQA-1, but it had never actually performed nuclear construction. "There wasn't an appreciation for what was involved," said Christenson. The general contractor enlisted some subcontractors with NQA-1 experience, which proved helpful.

Some of the issues the HEUMF team encountered along the way involved training of personnel, quality control of materials, and paperwork. For example, the HEUMF warehouse had storage racks graded as safety-class, which called for NQA-1 compliance. The racks included steel beams assembled onsite as well as bolts and nuts shipped to the site. When it came time to install the racks, the HEUMF team discovered that the installers lacked the necessary training. "There was very little formality about how it was being done to ensure consistent installation of the bolts," Christenson said. At one point, the management team stopped work to conduct training to make sure that the installers fastening the racks knew how to torque the bolts properly.

The inspection process uncovered some elongated bolts that had deformed during the installation process, which called into question the quality of the bolts. In reviewing the general contractor's procurement of the bolts, nuts, and washers, the HEUMF team discovered that the general contractor did pass on the 414.1C requirement, which allowed contractors to choose among of the national consensus standards. "ISO-9001 allows the organization to define a QA system that doesn't necessarily require the system to meet nuclear requirements," Christenson pointed out. The sub-tier vendors also contracted out to other sub-tier vendors, which pushed the issue down the supply chain. "There certainly wasn't an adequate understanding of what the nuclear quality requirements were through the flow-down of these specifications to the sub-tier vendors."

When the team realized it could not provide assurance of the quality of the bolts, it faced the prospect of having to test tens of thousands of bolts to make sure they met minimum requirements. Due to paperwork gaps, it was impossible to trace the origins of the bolts in some cases because of incomplete receipt inspections and records of where the bolts had been installed in the facility. The team ended up doing a sampling of the bolts that provided adequate quality assurance. "It was painful, and there was a fairly substantial cost associated with it," said Christenson. "It clearly created a risk for the project."

The importance of properly staffing the QA organization became apparent during concrete installation, when the project experienced a quality-related work stoppage of all construction activities. The rebar (steel used to strengthen concrete) being used was not the proper length. "We didn't have the right kind of inspections," said Christenson. The M&O contractor brought in an entirely new team and increased its QA staffing from a half-time person to a team. The general contractor also brought in a new QA organization at that point.

From the federal side, there was minimal oversight before the shutdown. "We didn't really have someone reviewing quality requirements from the federal perspective," Christenson said, noting that the DOE staffing to the point consisted primarily of an FPD and weak matrixed oversight support. After the 2006 shutdown, DOE added a quality engineer, a nuclear systems engineer, a safety oversight engineer, and a deputy to the FPD.

"It took us a long time to get to point where we had mutual understanding between the federal

team and the M&O about what nuclear QA meant," Christenson said.

Another lesson learned involved contract language. In its design specifications, the HEUMF project team didn't communicate to the general contractor whether a given system had a safety function, which allows the contractor to properly implement the requirements of NQA-1. As a result, the team had to perform commercial-grade dedication activities after the installation was completed. This required a significant amount of evaluation of design and testing documentation to prove that the critical characteristics had been satisfied.

"You need to plan up front to have the right amount of staff to support a nuclear facility that's going to implement NQA-1. They need to be trained and understand it, and they need to be involved in the procurement phases of the project. That sets the tone of it all," Christenson said. "The fundamentals are getting the right procurement language in place, having the right oversight of that by the M&O, and then from the federal perspective, making sure that the M&O is actually doing these checks prior to award in the procurement process to ensure that there's the right level of understanding among the vendors."

MIXED OXIDE FUEL FABRICATING FACILITY (MOX)

PROJECT PROFILE The MOX Facility at DOE's Savannah River Site will take surplus weapons-grade plutonium, remove impurities, and mix it with uranium oxide to form MOX fuel pellets for reactor fuel assemblies that will be irradiated in commercial nuclear power reactors. MOX, which has a total projected cost of $4.86 billion, is in active construction and procurement.

STATUS As of January 2011, the construction is just over 30 percent complete, and the project as a whole (including engineering design, construction, and testing) is 50 percent complete. MOX is unique among DOE facilities because its regulator is the NRC, rather than DOE.

The primary challenge related to NQA-1 implementation the MOX team has faced involves finding qualified vendors who understand the rigor of working under the standard. "We were fully cognizant of the difficulty of designing a first-of-a-kind nuclear facility," said Clay Ramsey, the MOX FPD. "What we did not allow for was that with the equipment suppliers who advertise that they have a NQA-1 program, those programs have sat on the shelf for many, many years." When the MOX team conducted audits of those vendors, Ramsey said, "It would quickly become apparent that the suppliers really didn't know what they were doing as far as NQA-1."

"These contractors didn't understand that there wasn't room for interpretation," said Sam Glenn, deputy FPD. "It calls for verbatim compliance and implementation. I think it would be fair to say it's been a shock to them."

These gaps in understanding among vendors have created unanticipated burdens. "A lot of unplanned effort has had to go into both the coaching and instruction of these suppliers, and the monitoring and oversight and additional inspection to make sure we're getting what we're supposed to get," Ramsey said, noting that the same phenomenon has occurred with construction subcontractors.

The implementation of NQA-1 has required significant resources to work with many of MOX's fifty-plus major equipment suppliers. In a number of cases, it has provided either a full-time engineer onsite to assist in understanding NQA-1 requirements and/or an inspector to verify and validate compliance with requirements. "It's a large number that we didn't really budget for just in terms of suppliers," Ramsey said. "We budgeted for audits, final inspections, and periodic inspections, but we didn't budget for having people onsite full-time through the life of these procurements." The same has been true for construction subcontractors. "In a number of cases, they have had to beef up their programs, and it has created cost pressure on them."

One example of the vendors' lack of understanding of NQA-1 concerns documentation and records.

"They end up heavily focusing on the hardware, and ignoring the documentation, which to us is almost as important as the hardware," Ramsey noted. "Those records are important to us, and we require that they be shipped with the piece of equipment. We don't accept the equipment shipped for payment until all the documentation is done, and a lot of these suppliers don't fully appreciate or focus on that." In a number of instances, the project team has received completed equipment but has had to wait days or weeks for the proper documentation.

The project team also encountered a QC issue with steel that it purchased through an NQA-1 supplier. "They purchased the steel through a subcontract and were supposed to be doing the inspections," Ramsey said. His team began noticing that the records were incomplete or had errors when the steel was delivered. Then it discovered that some of the product dimensions weren't right. "We found that even though we had done checks and audits, the NQA-1 supplier wasn't really doing the things they were supposed to be doing. They weren't doing the checks that were part of the contract."

Another issue the project team has encountered is the need for commercial-grade dedication. "It is an across-the-board issue, from raw materials to fasteners, motors, valves, scales, and even computer software and hardware," said Mosi Dayani, lead QA specialist for the MOX project.

Due to the variety of equipment requiring commercial-grade dedication, the program needs to address different methods of providing quality assurance. Equipment with computer chips and software poses new challenges. "Some of the equipment that went into nuclear facilities 20 years is not the equipment that's going in now," said Ramsey. "It's one thing for the contractors to develop a dedication program, but the regulators don't have a lot of experience in assuring themselves that the programs are adequate. There's uncertainty."

Ramsey emphasized that project teams need to build in allowances to deal with capability gaps among suppliers. "There's nothing out there that can support the kind of major construction project that MOX or a new commercial reactor would require. The supplier base doesn't exist," he said. "If we were trying to do this 30 years ago, there would be a supplier market for many of the pieces of equipment we're trying to buy. We wouldn't be having a lot of the challenges that we've had."

The MOX project team has been working with other DOE organizations as well the NRC to address issues with vendors. Ramsey noted that there have been vendor forums to educate industry about the opportunities and requirements associated with an NQA-1 program. It has also conducted lessons learned exchanges with other DOE project teams in order to learn from and share with others.

SODIUM BEARING WASTE TREATMENT FACILITY (SBWTF)

PROJECT PROFILE The SBWTF is being constructed to treat sodium-bearing waste and other waste types at the Idaho National Laboratory.

STATUS The facility is currently on target to receive its CD-4 approval signifying project completion in late November or early December 2011.

The SBWTF is unique compared to other DOE nuclear construction projects. It has a relatively small number of safety-significant systems (10) compared to facilities such as MOX. NQA-1 compliance has not posed a significant challenge for the project management team or its contractors. According to Greg Hayward, lead QA specialist, the contractors that did the engineering design work for SBWTF during CD-1 and CD-2 understood what NQA-1 entailed. “A lot of the engineers are familiar with NQA-1 because it’s been around for a long time. It’s not anything new,” he said.

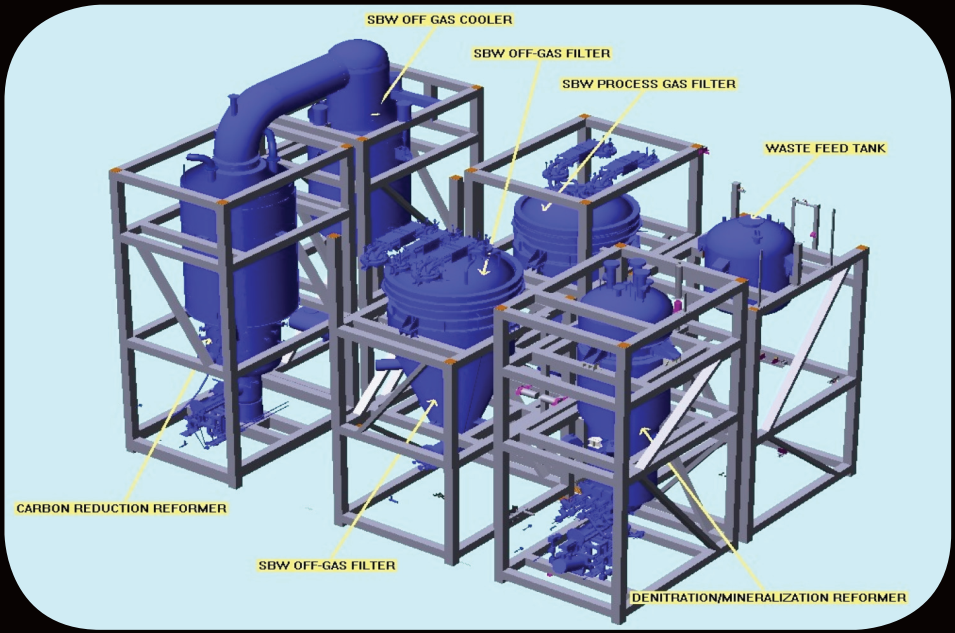
The primary NQA-1-related issues have concerned staffing. “The rigor of a Category-2 nuclear facility calls for getting the right people who are trained and qualified to do the work and handle the associated documentation that’s required,” said Hayward. “We’ve had a hard time getting nuclear-qualified inspectors. The challenges have been with the paperwork—getting them to understand the importance of it, the rigor, and getting it in its proper format. That’s been our biggest challenge, and continues to be so.”

While many experienced engineers on SBWTF are familiar with NQA-1 across the Idaho facility, there has been a learning curve for others. “The work with NQA-1 has been a challenge for some of the new engineers,” Hayward noted, “however, the procedures being written to implement NQA-1 are robust.”

The SBWTF QA team has encountered some issues with workmanship and documentation, though none have risen to a high level,” according to Hayward. The structural steel supplier, a NQA-1 shop, had verified the steel as acceptable for the design, but when the steel arrived at the site, the SBWTF QA team discovered holes and plates in the wrong spots, and twisting in some of the beams. “We worked through it, but it did take additional time and money to get those things ironed out,” Hayward said. “We’ve seen some (problems), but it hasn’t been anything that we would consider an ongoing issue.”

The QA team has had to conduct some commercial-grade dedication. “It has added to the expense of the project because companies would rather build pumps, for instance, for the commercial market rather than take on the cost of the additional documentation and demonstrated compliance that go with these contracts,” Hayward

pointed out. "It becomes expensive because of the additional documentation that goes into a nuclear procurement." Hayward estimated that the overall cost of commercial-grade dedication has been negligible for the project—there have been perhaps 20 unique pieces of equipment requiring the process—but the cost for individual pumps and valves may have increased.



Software is one area that has posed new challenges in terms of NQA-1 compliance. "We have more people working on software than in the past," said Hayward, noting that SBWTF has far more digitally automated systems than earlier facilities had.

From Hayward's perspective, NQA-1 compliance may save money by preventing costly quality failures with safety significant systems. "I think it would cost us more money if we didn't have it. We have certain specifications and codes that we have to meet, and NQA-1 helps organizations focus in on those requirements," he stated. "If we didn't have that, it could cost the government more. It might make life easier on the contractors, because there are accountabilities built into NQA-1, but overall I think it saves us money."

IMPLICATIONS FOR FUTURE DOE PROJECTS

The two greatest challenges that FPDs face related to NQA-1 compliance are 1) gaps in the existing vendor base, and 2) a lack of qualified personnel on their teams to conduct the necessary inspections, audits, and surveillance. Both issues are likely to continue in the medium term.

The vendor base is a function of the size of the market for nuclear construction. In the current economic downturn, it is hard to foresee a boom in large-scale commercial or government-funded projects that would expand that market to the point where a significant number of vendors would have incentives to enter. Attracting vendors by itself will not solve the problem; vendors also need to understand the rigor associated with nuclear safety requirements in order to execute an effective NQA-1 program.

This will require knowledge and learning across the vendor base. DOE can accelerate this process by continuing to hold vendor forums and educate partners in industry about the opportunities in and requirements of nuclear construction. While the vendor base is maturing, DOE can find potential efficiencies by sharing commercial-grade dedication programs among facilities (as requirements allow) and promoting information exchanges among facility managers about acquisition strategies and practices (as permitted by regulations).

The lack of qualified personnel is likely to continue due to intense pressure on federal budgets and the relatively small number of opportunities for hands-on learning on nuclear construction projects. In this context, FPDs assigned to new nuclear facility projects should plan to dedicate sufficient resources upfront to work closely with vendors who may not have extensive experience with NQA-1 and run robust commercial-grade dedication programs in the absence of qualified vendors. Again, the sharing of information and best practices among DOE facility managers can help to enable realistic resource planning in the early stages of a project.

APPENDIX A – BACKGROUND INTERVIEWS

In addition to DOE officials quoted in the paper, the following experts participated in background interviews:

Jim Broughton, Applied Engineering Services, Inc.

Jeffrey Larson, Invensys

Jack Kasper, Parsons Corporation

Ted Quinn, Longenecker and Associates

David Swindle, URS Corporation

Ed Webb, private consultant (retired, Tennessee Valley Authority)